Firmware Release Notes - BTM510/BTM511

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1. Firmware Version 14.1.1.0

1.1 Features

- Bluetooth 2.1 / 2.1+EDR
- Supported Profiles:
  - Serial port profile (SPP)
  - Advanced Audio Distribution Profile (A2DP, Source / Sink)
  - Audio/Video Remote Control Profile (AVRCP, Control / Target)
  - Hands-free Profile (HFP, Hands-free unit and Audio Gateway)
  - Headset Profile (HSP, Headset and Audio Gateway)
  - Dial-up Network Profile (DUN, Dial Terminal)
- SCO/eSCO audio connection
- Sniff mode
- Standard / non standard UART baud rates configurable
- Secure simple pairing (SSP)
- Extended inquiry response (EIR)
- CSR Bluestack build 5365 (native mode, 56bit encryption, 23e)
- Bluetooth approval, listed under QDID B016227
- Tested by regression tests

1.2 Changes in AT command set (compared to 14.0.0.11)

- New feature “Call Records”: AT+HFGC? – query call records
- New S-register: S354 – enable/disable verbose mode for call record presentation
- New command: “AT+HFGB0/1” (disable/enable in-band-ringing) when SLC connected
- HF state (ATI65) enhanced by 5 (call setup – SLC) and 6 (call setup – audio)
- “AT+HFGH” returns ERROR 63 when issued during a call setup state (ATI66 = 5 or 6)
- “AT+HFGA” and “AT+HFGR” return ERROR 63 when issued during a call setup state (ATI66 = 5 or 6)

1.3 Bugs fixed (compared to 14.0.0.11)

- AVRCP: a BTM410/411 has refused incoming AVRCP connections (observed in CT and TG role); this has been fixed [Ref. 0-2; 0-3]
- AVRCP: company ID was incorrect in “AVUR” response to “AT+AVU”; this has been fixed [Ref. 0-4]
- AVRCP: operation ID “previous channel” (0x32) missing in documentation, Operation IDs 0x32…0x37 wrong by one in documentation; has been corrected in documentation and

updated in firmware. The previously wrong operation IDs have been shifted by one to be correct, e.g. “page down” corresponds to 0x38. [Ref. 0-6]

- ATS690=? has reported 215..215. This issue has been fixed [Ref. 0-7]
- AT+GIU and AT+GOU went up to 23 but maximum value is 22. This is fixed now. [Ref.0-8]

1.4 Known Issues

- GPIOs not accessible by AT-commands, [Ref. 1-5]
- In some cases General Bonding (automated pairing during connection setup) with **legacy** devices (BT2.0 or earlier) does not work. It did not work when tested against a BISM2. However the issue did not appear when tested against a BTM510 that was converted to BT2.0. or when tested against a BTM430 (BT2.0). This implies that this issue is likely to be caused by the remote device. [Ref. 1-1]

  Workaround: use AT+BTW<BdAddr> to initiate dedicated bonding prior to connection establishment with a legacy devices.
- S324 is ignored, SSP timeout is fixed to about 30 seconds (probably error in CSR library) [Ref. 1-3]
- When the link key for a device is existing locally (AT+BTT? or AT+BTW?) but the link key is missing in the remote device (e.g. it was deleted there), creating a connection (AT+SPD<BdAddr>) will result in NO CARRIER rather than new pairing. This issue is caused by the underlying Bluetooth stack and can only be resolved with a future update. The first number of the firmware version (14 here) indicates the Bluetooth stack version in use. So in every firmware version beginning with ‘14’ this issue will be present. [Ref1-7]

  Workaround (a) (recommended): use AT+BTW<BdAddr> to initiate new pairing to generate new link keys on both devices.

  Workaround (b): the link key for the remote device can be deleted from the trusted device list (AT+BTD<BdAddr>) or from cache (AT+BTDW). A new connection attempt (AT+SPD<BdAddr>) should initiate new pairing automatically. However, this might not work with some legacy (BT2.0 and earlier) devices. Hence workaround (a) is recommended.
- All profiles: It has been observed, that after profile disconnection (“NO CARRIER”) a delay of at least 200ms is required, before the module can initiate a connection again successfully. [Ref. 1-8].
- AVRCP: It has been observed that on a link between two BTM510/511, one end configured as target (TG), the other end configured as control (CT), a value of “Bad profile” in S311 (AVRCP response type) at the target side is causing a timeout response (AVPTC 4,<OpId>,0) to AT+AVC<OpId> issued at the CT side. It has not been clarified if this issue is caused by either TG or CT. [Ref. 1-9]
- HFG: “AT+HFGE<ext_err_code>”: an issue with extended error codes has been observed. AT+HFGE<ext_err_code> does not work as expected. Workaround: do not use extended error codes but simple error messages, i.e. AT+HFGE (without parameter). [Ref. 1-10]
- HFG: “ATH11F” does not release SLC but returns ERROR 56. Workaround: use “AT+HFGH“ instead. [Ref.1-11]

- HFG: “ATH*” displays “NO CARRIER” but does not release the SLC. Workaround: use AT+HFGH instead [Ref. 1-12]
- HFG, call records: There are currently no AT command available for the following purposes:
  - Clear a waiting call [Ref. 1-16]
  - Make a held call active [Ref. 1-17]
  - Clear a held call [Ref. 1-18]
- Multiple profiles: The usage of multiple profiles at the same time (other than A2DP and AVRCP) has not been tested and might cause issues. Only the profile(s) which is/are used shall be enabled. If too many profiles are enabled, the module can become instable and reboot due to lack of memory. [Ref 1-21]
- Multiple profiles: A2DP-SNK, AVRCP-CT, HF : this scenario would require additional AT commands and S registers which are not available with this firmware.
- A2DP-SNK: when connected to an A2DP source and streaming audio, sometimes gaps in the audio stream have been observed. This was due to the module still being in discoverable and connectable state after A2DP has connected. The problem could be solved by issuing “AT+BTX” (make module not discoverable and not connectable). [Ref. 1-23]
- Undocumented usage of LED1 to indicate audio related states (e.g. loopback) can disturb normal operation of LED1 [Ref. 1-24]
- Module is not discoverable after releasing an SPP connection (ATH) while S512=4 [Ref 1-25]

1.5 Interoperability tests with mobile phones

Phone	Test (role of BTM51x)	Result / Comment
HTC Touchpro 2 (windows mobile, BT2.1)	Inquiry/Pairing	no serious issues
	HFP (HF)	no serious issues
	HSP (HS)	incoming connection accepted by phone, but no audio is initiated by phone when AT+HSB was issued at BTM
	DUN (DT)	no issues
Sony Ericsson K800i (BT 2.0)	Inquiry/Pairing	no issues
	HFP (HF)	no issues
	HSP (HS)	not supported by phone
	DUN (DT)	no issues
Nokia E71 (BT 2.0)	Inquiry/Pairing	BTM can be found by phone, pairing can be initiated by phone

	HFP (HF)	connection from BTM is accepted but released immediately by the phone.
	HSP (HS)	Not tested
	DUN (DT)	Not tested

2. Firmware Version 14.1.1.1 (engineering firmware)

2.1 New Features (compared to v14.1.1.0)

- support for simultaneous A2DP + HFP added
- support for extended inquiry response (EIR) data enhanced, enabling up to 240 Bytes of EIR data

2.2 New AT commands

- AT+APU : suspend A2DP streaming but retain A2DP link
- AT+APR : resume A2DP streaming
- AT+BTE : clear EIR data from baseband
- AT+BTE? : query EIR data from baseband
- AT+BTE=”<data>” : write EIR data to RAM buffer and baseband
- AT+BTE=”” : delete EIR data from RAM buffer and baseband
- AT+BTE+”<data>” : append EIR data to RAM buffer
- AT+BTE~ : copy EIR data from RAM buffer to baseband
- AT+BTE+? : query EIR RAM buffer
- AT+BTE+”” : clear EIR RAM buffer
- AT+BTEW : copy EIR RAM buffer to persistent store
- AT+BTED : delete EIR data from persistent store
- AT+BTEW? : query EIR data from persistent store,

note: the content of the persistent EIR data storage is copied to the baseband at boot time

2.3 New S-Registers

- S355 : audio resource override [0..3], default = 1:
  - 0 = no override allowed
  - 1 = incoming/outgoing SCO request will be accepted while A2DP is streaming. The module will initiate A2DP suspend automatically (default)
  - 2 = incoming/outgoing A2DP start/resume request will be accepted while SCO is active. The module will release the SCO link automatically
  - 3 = combination of 1 and 2
- S356 : enable restoring of last gain used for SCO [0..3], default = 3:
  - 0 = Disable gain restoring for SCO
  - 1 = Enable output gain restoring for SCO
  - 2 = Enable input gain restoring for SCO
  - 3 = Enable input and output gain restoring for SCO
- S357 : enable restoring of last gain used for A2DP [0..3], default = 3:

- 0 = Disable gain restoring for A2DP
- 1 = Enable output gain restoring for A2DP
- 2 = Enable input gain restoring for A2DP
- 3 = Enable input and output gain restoring for A2DP

2.4 New unsolicited messages

- APSTR,< : streaming started, initiated remotely
- APSTR,> : streaming started, initiated locally
- APSUS,< : streaming suspended, initiated remotely
- APSUS,> : streaming suspended, initiated locally

2.5 New ATIs

- ATI61:
  - 0 = A2DP not connected
  - 1 = A2DP connected and streaming
  - 2 = A2DP in suspended state (connected but not streaming)
- ATI21: SCO token, index of the profile instance owning an active SCO connection (0=none, 1=HS, 2=HSG, 3=HF, 4=HFG, 5=SPP_BTA)
- ATI22: last SCO output gain
- ATI23: last SCO input gain
- ATI24: last A2DP output gain
- ATI25: last A2DP input gain

2.6 New Error Codes

- 76: memory allocation attempt was unsuccessful
- 77: incorrect A2DP state (see ATI61)
- 78: request rejected due to priority (related to S355 settings)

2.7 Other changes

- Maximum number of trusted devices changed from 10 to 9 (ATI6)
  - Direction indication (incoming=“,<” / outgoing=”,>”) for A2DP CONNECT messages

2.8 General information

This release (v14.1.1.1) is engineering firmware and must be used for development only. The new features of this release are not covered yet by automated regression tests. There have been plenty of manual sanity checks but there might still be bugs and untested use cases left.

2.9 Bugs fixed (compared to 14.1.1.0)

- Deprecated undocumented usage of LED1 to indicate audio related states (e.g. loopback) [Ref. 1-24]
- Module was not discoverable after releasing an SPP connection (ATH) while S512=4 [Ref 1-25]. This issue has been fixed.

2.10 Known Issues

- It has been observed that an A2DP source with an active SCO connection (HFG) will reject an incoming A2DP connection request if A2DP is not allowed to override SCO (S355). In the same circumstance the A2DP source can initiate an outgoing A2DP connection, but it will not initiate the start of the A2DP stream. This is not really an issue, but the different behaviour towards incoming and outgoing connections might not be expected as this.
- It has been observed that the audio related USMs for HFP and HSP (e.g. HF"AU1" / HFG"AU1" / HS"AU1" / HSG"AU1") can appear as „AUDIO ON (SCO)" or "AUDIO ON (eSCO)". This not intended and can happen if SPP is enabled along with HFP or HSP. Workaround: disable SPP in S102 if not needed. [Ref 1-26]

3. Firmware Version 14.1.1.2 (engineering firmware)

3.1 New Features (compared to v14.1.1.1)

- APTX codec for A2DP source (fully) and sink (demo) supported:
  - analogue input and analogue output mode
  - decoder demo for 5 minutes, encoder fully functional
  - See S-Register 307
- Configure UART for high throughput or low latency
  - See S-Register 544

3.2 New ATI commands

- ATI26: query active A2dp codec
  - Response if S333=1 (verbose mode):

    “NONE” / “SBC” / “APTX”
  - Response if S333=0 (non-verbose mode):

    “0” / “1” / “2” whereby 0=None, 1=SBC, 2=APTX
  - Note: S333 has been associated with HFP (Hands-free profile) so far, but now becomes more to a global verbose enable / disable register.
- ATI27: query current scan state
  - 0 = not discoverable and not connectable (not scanning)
  - 1 = discoverable (inquiry scanning)
  - 2 = connectable (page scanning)
  - 3 = discoverable and connectable (inquiry- and page-scanning)

3.3 New S-Registers

- S307 : optional A2DP codec enable [0..1], default = 0:
  - 0 = no optional codec
  - 1 = aptX
  - Notes:
    1. aptX must be enabled on both ends. If aptX is not enabled on both ends, then SBC will be selected automatically on an A2DP connection. Check with ATI26 which codec is actually in use.
    2. S307 is queried at boot time. So after writing a new value, issue AT&W and ATZ for the new value to become effective.
    3. SBC is the mandatory codec and therefore not in the optional codec list
- S308 : Auto-BTX on A2DP connection [0..3], default = 3:

- 0 = do not change discoverable and connectable state when entering or exiting an A2DP connection
- 1 = make the module not discoverable and not connectable when entering an A2DP connection (Bit1)
- 2 = restore discoverable/connectable state according to S512 when exiting an A2DP connection (Bit 2)
- 3 = combination of 1 and 2
- Notes:
    1. Inquiry scanning and page scanning (discoverable and connectable state) consume bandwidth which and cause insufficient bandwidth for the audio stream. If both ends are discoverable and connectable, then dropouts in the audio stream can be expected. Bit 1 of this S-Register has the same effect as issuing AT+BTX after an A2DP link has been established. (That is why it has been named “Auto-BTX”).
    2. AT+BTG/Q/P will work normal when issued while in an A2DP connection. However, if Bit2 is enabled, the changed scan-state may be overridden by the settings of S512 when exiting the A2DP connection
    3. The current scan state can be checked by new ATI27.

- S544 : configure UART for high throughput or low latency (default=1,high throughput):
    - 0 = low latency
    - 1 = high throughput (default)
    - A new setting needs subsequent “AT&W” (store value) and “ATZ” (reset) before it becomes effective

3.4 Other changes

- Maximum number of trusted devices changed back from 9 to 10 (ATI6)

3.5 General information

This release (v14.1.1.2) is engineering firmware and must be used for development only. The new features of this release are not covered yet by automated regression tests. There have been manual sanity checks but there might still be bugs and untested use cases left.

3.6 How to enable APTX

Source	Sink	Comment
AT&F*	AT&F*	Restore factory default settings
ATS307=1	ATS307=1	Enable APTX
ATS300=2		Enable Source role
ATS512=4		Make connectable and discoverable
AT&W	AT&W	Store S Register configuration
ATZ	ATZ	Reset
	AT+APD<Bluetooth	Initiate connection. Get Bluetooth

	Address Source>	address of other end by ATI4 on other end or by inquiry (AT+BTI).
ATI26	ATI26	Verify codec in use (“APTX” / “SBC”)

- Note: the APTX decoder (sink role) will mute after about 5 minutes. This is due to APTX licensing. If your are interested in getting a full decoder license, please contact Laird Technologies. The APTX encoder (source role) is fully functional.

3.7 Bugs fixed (compared to 14.1.1.1)

- If S504=1 (silent operation enable), the “CONNECT” message was not suppressed on “ATO”, this has been fixed [Ref. 1-27]
- New S308 is automating the workaround of AT+BTX after creation of A2DP connection [Ref 1-23]

3.8 Known Issues

- See section 2.10

4. Firmware Version 14.1.2.0 (production firmware)

4.1 New Features (compared to v14.1.1.2)

- I2S digital stereo audio interface support:
  - Enabling use of external codecs or wave file player/recorder
  - Master or slave role selectable
  - Test mode: I2S cross loopback (internal codec), bidirectional audio
  - Sampling frequencies supported by external codec configurable by S316
- GPIOs (general purpose input/output) support:
  - 4 freely usable GPIOs available
  - Function mapping (e.g. volume up/down, headset button etc.)
  - AVRCP operation id mapping (e.g. Play/Stop/Pause etc.)
- Full APTX license for all modules from production (not for field upgrade)
- EIR (extended inquiry response data) improved, maximum data length = 160 Bytes
- Tested by regression tests
- All features of previous production and engineering firmware (v14.1.1.0, v14.1.1.1, v14.1.1.2)

4.2 New and enhanced AT commands

- AT+BTL3: I2S cross loopback mode, I2S master, sampling rate defined by S419
- AT+BTL4: I2S cross loopback mode, I2S slave, sampling rate defined by S419

4.3 New ATI commands

- ATI28: query current audio sampling rate, displayed for input and output
- ATI29: query maximum data length for EIR data
- ATI30: query current RAM buffer length (EIR)
- ATI31: query current baseband buffer length (EIR)
- ATI411: short press duration (time in ms)
- ATI412: medium press duration (absolute time in ms, S411+S412)
- ATI413: long press duration (absolute time in ms, S411+S412+S413)

4.4 New S-Registers

- S309: Enable asynchronous “FS” message (currently used sampling frequency)
  - 0=disable, 1=enable (default)
- S314 : A2DP audio interface select
  - 0=internal (default), 1=I2S master, 2=I2S slave
- S315 : SCO audio interface select

  - 0=internal (default), 1=I2S master, 2=I2S slave
- S316 : external codec sampling frequency capabilities for A2DP
  - Referenced only if S314>0 and only for A2DP links
  - Register values: (values can be added for all sampling frequencies supported)
    1 = 48kHz, 2 = 44.1kHz, 4 = 32 kHz, 8 = 24kHz*, 16 = 22.05kHz*, 32 = 16kHz
    *not supported by SBC nor APTX, value is ignored
- S650: GPIO pin state mask
  - 0 = configuration field enabled, 1 = pin state mask for S651..S658
- S651..S658: GPIO configuration registers, for details see below “GPIO Configuration”
- S669: GPIO input strong bias enable bitmask
  - 1 = enable strong internal pull up/down if GPIO is an input
  - 0 = enable weak internal pull up/down if GPIO is an input
- S670: read/write pin states of all GPIOs in one step
- S411: short press duration in (ms), granularity 200ms
- S412: medium press duration in (ms), added to value of S411, granularity 500 ms
- S413: long press duration (ms), added to values of S411+S412, granularity 500ms

4.5 New asynchronous messages

- Current sampling frequency:
  “FSddddd,<interface>” whereby:
  ddddd=sampling frequency in Hz (4 or 5 digits)
  <interface> = “INT” (internal codec) / “I2S_M” (I2S master) / “I2S_S” (I2S slave)
  FS-message can be disabled by S309 or S504.

4.6 New Error Codes

- 79: writing to modem control line is not permitted by GPIO S-register
- 80: attempting to write the pin state of a GPIO that is configured as input
- 81: Maximum size of EIR data exceeded (ATI29)

4.7 General information

All Features described for this firmware version (v14.1.2.0) have been tested by automated regression tests to a reasonable level. A number of bugs have been found and were fixed before releasing this firmware.

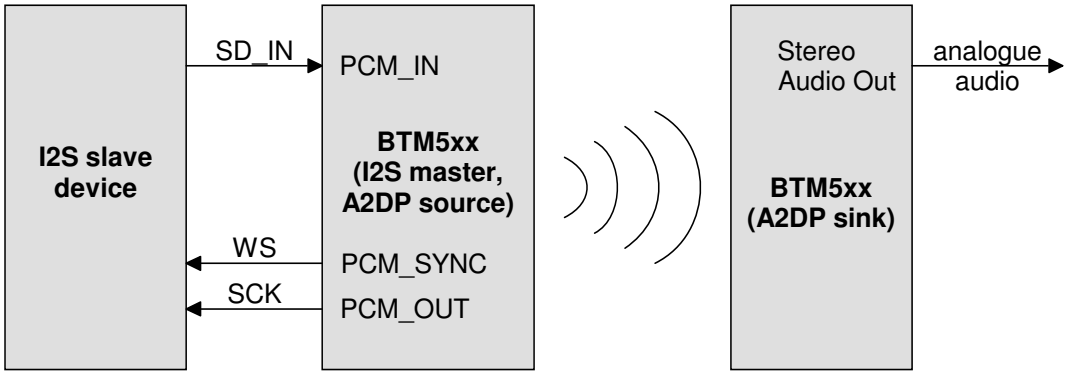
4.8 How to use I2S

I2S signals are mapped to the PCM pins of BTM51x as outlined in this table:

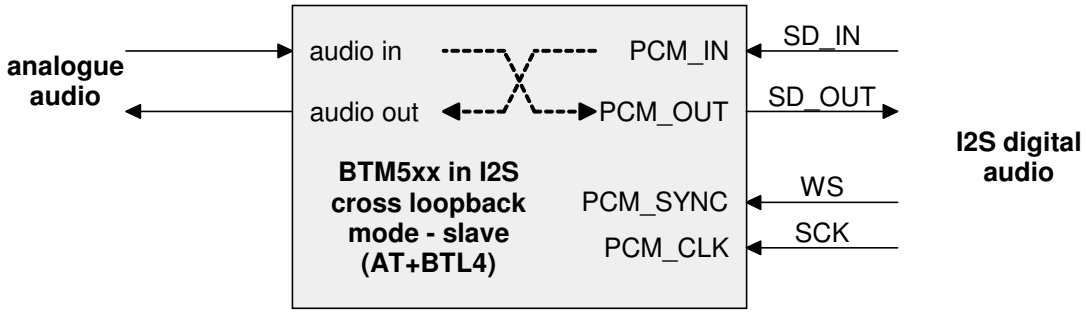
I2S Signal name	BTM51x Signal name	BTM51x module pin	Mini devkit PCM	Comment

		no.	header (J5)	
SD_IN	PCM_IN	3	5	I2S Serial data in
SD_OUT	PCM_OUT	4	7	I2S Serial data out
WS	PCM_SYNC	5	6	I2S Word select (right/left ch)
SCK	PCM_CLK	6	4	I2S clock
	GND1/2/3/4	[9,22,13,47]	10	GND

Connect an I2S (slave) source as outlined in the following block diagram. The SD_OUT connection is not needed for the example below.



A third BTM5xx can be utilised as an I2S slave device. This third BTM5xx is configured for I2S cross loopback mode by AT+BTL4. It then acts as analogue-to-I2S converter:



The following table lists all AT commands required for this scenario:

Analogue to I2S converter (1)	A2DP Source with I2S input	A2DP Sink with analogue output	Comment
AT&F*	AT&F*	AT&F*	Restore factory default settings
AT+BTL4			Configure I2S (slave) source (1)
	ATS314=1		Select I2S (master) interface at A2DP source
	ATS300=2		Enable Source role
	ATS512=4		Make connectable and discoverable

	AT&W	AT&W	Store S Register configuration
	ATZ	ATZ	Reset
		AT+APD<Bluetooth Address Source>	Initiate connection. Get Bluetooth address of other end by ATI4 on other end or by inquiry (AT+BTI).
1) for demonstration purposes or if no other I2S source is available, a 3rd BTM5xx can be used as analogue to I2S converter in I2S cross loopback mode.			

4.9 GPIO configuration

A GPIO pin is configured by S651…S658 according to the following bit mapping:

Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	function mapping code / av_operation_id								reserved		FMS		NEN	INV	DIR	PS
Default	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Field	Description
0 – PS	I/O Pin State – returns the current state of the I/O pin (0/1) when read A write affects the I/0 pin directly if DIR=1 and FME=0
1 – DIR	Direction – controls if the I/O pin is an input or an output 0 input 1 output
2 – INV	Inversion – controls if the I/O pin is inverted or not. Applies to both pin directions (read and write). 0 not inverted 1 inverted
3 – NEN	Notification enable – sends a notification to the host via UART on each status change if the GPIO is an input. AT&W and ATZ is required for a new setting to become effective. Notification format:: "\r\nGPIOx,y\r\n" x=GPIO index [1..8]; y=new pin state [0..1] with INV flag applied 0 disable notification 1 enable notification
4 – FMS	Function Mapping Select – Selects modem control function, AVRCP operation id or Function Mapping Code 0 FMS_NONE – function mapping disabled 1 FMS_MODEMCTRL – use GPIO as modem control line 2 FMS_AVRCP_OP – bits [8:15] specify AVRCP operation ID 3 FMS_MAPCODE – bits [8:15] specify Function Mapping Code
[5:7]	Reserved
[8:15] function mapping code / av_operation_id	A Function Mapping Code or an av_operation_id is set in this bit field. The pin is mapped to a profile specific function (A2DP,HFP) or to an AVRCP remote control operation and will carry out the assigned operation. A mapped function does not affect any other flag of the GPIO configuration register. So, e.g. DIR and INV must be set manually according to the selected function and hardware requirements. Valid only if FMS>=2. FMS selects function mapping code or av_operation_id.

Value	Function Mapping Code – Input
0x00	Cable Replacement TX
0x01	RFC_RTC_TX
0x02	RFC_RTR_TX
0x03	RFC_IC_TX
0x04	RFC_DV_TX
0x05	Volume down single step
0x06	Volume up single step
0x07	Volume down multiple after short press
0x08	Volume up multiple after short press
0x09	Volume down multiple after medium press
0x0A	Volume up multiple after medium press
0x0B	Headset Button
0x0C	HF green button
0x0D	HF red button

Value	Function Mapping Code – Output
0x00	Cable Replacement RX
0x01	RFC_RTC_RX
0x02	RFC_RTR_RX
0x03	RFC_IC_RX
0x04	RFC_DV_RX

4.10 Bugs fixed (compared to 14.1.1.2)

- The implementation of the EIR commands (AT+BTE family) have shown a number of instabilities in previous f/w versions. Many of these issue have been resolved and the EIR implementation can be regarded as much more stable with this version. It was also found that the maximum EIR data length is limited to 160 Bytes due to internal memory limitations. [Ref. 1-28]
- When inquiring with friendly name (e.g. AT+BTIN) and a remote device was discoverable but not connectable, this remote device was not listed in the inquiry results though discoverable. This has been fixed now. If the friendly name cannot be retrieved (e.g. due to not connectable), then a '!' will be displayed instead of the friendly name. [Ref 1-29]
- Range of S102 limited to 0...$1FF (was 0..$7FF)

4.11 Known Issues

- The maximum length for extended inquiry data is 160 Bytes. The Bluetooth specification allows up to 240 Bytes, but this cannot be achieved on BTM510/511 due to internal memory limitations. [Ref 2-1]
- 4 out of the 8 GPIO lines are bound to modem control line functionality (DTR, DSR, DCD, RI). Hence, only the 4 remaining GPIO lines are "real" GPIOs. [Ref 2-2]
- External audio codec sync: in addition to the I2S signals (SD_IN, SD_OUT, WS, SCK) , external audio CODECS often require a high frequency synchronisation clock from one master clock source in the system. This master clock would typically be the BTM51x and the clock frequency would be in the range of 12MHz or 24 MHz or similar. BTM51x cannot provide this clock to an external I2S device. BTM52x possibly can, but confirmation an tests are still outstanding. If this high frequency clock synchronisation is missing, artefacts will be audible in periodic intervals. In the use case of a wave file

player/recorder (no codec) the I2S signals are sufficient and no HF synchronisation is required. [Ref 2-3]

- Auto connection at boot time (AT+BTR) only applies to SPP [Ref. 2-4, 1-4]
- S324 is ignored, SSP timeout is fixed to about 30 seconds (probably error in CSR library) [Ref. 2-5, 1-3]
- When the link key for a device is existing locally (AT+BTT? or AT+BTW?) but the link key is missing in the remote device (e.g. it was deleted there), creating a connection (AT+SPD<BdAddr>) will result in NO CARRIER rather than new pairing. This issue is caused by the underlying Bluetooth stack and can only be resolved with a future update. The first number of the firmware version (14 here) indicates the Bluetooth stack version in use. So in every firmware version beginning with '14' this issue will be present. [Ref. 2-6, 1-7]

  Workaround (a) (recommended): use AT+BTW<BdAddr> to initiate new pairing to generate new link keys on both devices.

  Workaround (b): the link key for the remote device can be deleted from the trusted device list (AT+BTD<BdAddr>) or from cache (AT+BTDW). A new connection attempt (AT+SPD<BdAddr>) should initiate new pairing automatically. However, this might not work with some legacy (BT2.0 and earlier) devices. Hence workaround (a) is recommended.
- It has been observed that the audio related USMs for HFP and HSP (e.g. HF"AU1" / HFG"AU1" / HS"AU1" / HSG"AU1") can appear as „AUDIO ON (SCO)" or "AUDIO ON (eSCO)". This not intended and can happen if SPP is enabled along with HFP or HSP. Workaround: disable SPP in S102 if not needed. [Ref 2-7, 1-26]
- ATH* and ATH111E do not work with HS instance (Headset unit of HSP), workaround: use AT+HSH instead. [Ref. 2-10]
- HFG, call records: There are currently no AT command available for the following purposes:
  - Clear a waiting call [Ref. 2-11, 1-16]
  - Make a held call active [Ref. 2-12, 1-17]
  - Clear a held call [Ref. 2-13, 1-18]
- HFG: "AT+HFGE<ext_err_code>": an issue with extended error codes has been observed. AT+HFGE<ext_err_code> does not work as expected. Workaround: do not use extended error codes but simple error messages, i.e. AT+HFGE (without parameter). [Ref. 2-14, 1-10]
- EIR: after repeatedly issuing AT+BTE+? or AT+BTEW? (provided data is stored in the RAM and persistent buffer) the commands stop working or only display a part of the buffered data. It was not possible to manually reproduce this issue consistently.[Ref.2-20]

5. Firmware Version 14.1.2.1 (engineering firmware)

5.1 General information

This firmware is an engineering release for a particular project. It contains a new feature for a HF to request creation of DTMF tones from a HFG (e.g. mobile phone) as well as a couple of bug fixes.

This release is engineering firmware and must be used for development only. The new features of this release are not covered yet by automated regression tests. There have been manual sanity checks but there might still be bugs and untested use cases left.

5.2 New AT commands

- AT+HFM<x> (with <x>=0…9,*,#,A...D) : request a DTMF tone to be created by a connected HFG (e.g. mobile phone). The command “AT+VTS=<x>” is sent on the SLC. Refer to HFP 1.5 specification, feature 17 / section 4.27.

  Has been tested with an iPhone (COD: S515=$200404) and a Samsung E250.

5.3 Bugs fixed (compared to 14.1.2.0)

- Secure Simple Pairing (SSP): leading zeroes were not displayed in the SSP passkey of the following asynchronous messages:

  PAIR ? <BdAddr>, “<friendlyname>”,<Passkey>

  PASSKEY N <BdAddr>,”<friendlyname>”,<Passkey>

  Therefore it was possible that passkey contained less than 6 digits. This has been fixed now. Leading zeroes will be inserted so that a 6 digit passkey will be guaranteed in any case. [Ref 2-25]

- Serial Port Profile (SPP): On the hang-up attempt of the 7th SPP connect/disconnect cycles, the module went through a reset automatically. This could possibly lead to issues because this behaviour is probably not expected by the host controller. However, this issue has been fixed now. [Ref 2-21]

- Serial Port Profile (SPP): When issuing AT+BTX (disable discoverable and connectable) in command and connected mode of SPP, and subsequently issuing ATO, ERROR 04 was returned which was preventing the return to data and connected mode (SPP). This issue has been fixed. [Ref. 2-26]

6. Firmware Version 18.1.2.2 (engineering firmware)

This engineering release was a preview version for 18.1.2.3 and was not distributed widely.

Version 18.1.2.2 is identical with 18.1.2.3 from the feature's prospective.

However, 18.1.2.2 contains a bug which blocks incoming audio in a SCO link if CVC is enabled. This issue is fixed in v18.1.2.3.

7. Firmware Version 18.1.2.3 (engineering firmware)

7.1 New Features (compared to v14.1.2.1)

- "Clear Voice Capture" (CVC) support, configurable DSP algorithms for noise reduction and echo cancellation (NREC) provided by CSR:
  - 5th generation of CVC
  - Applies to the Headset / Hands-free unit of a SCO connections (e.g. HFP)
  - HS1mic / HS2mic / HF1mic selectable:
  - See also: "CVC on BTM5xx", application note provided by Laird Technologies
- New bluestack firmware:
  - New version = 23i
  - Build number = 6530 (ATI1)

7.2 New AT commands

- AT+HFZ

  Disable NR/EC in HFG (AT+NREC=0 sent on SLC, Feature #14_4.24 of HFP1.5 spec); only allowed if both HF and HFG have declared NREC support in their HF/HFG supported features (see S581 {HF} and S596 {HFG})

- AT+HFF?

  Query local (HF) and remote (HFG) supported features (SF). HFP SLC is required.

  Response: <HF_SF>,<HFG_SF>

7.3 New ATI commands

- ATI32: query CVC license key
- ATI35: query list of available CVC images with SYSID, security status, technical name and SDK
- ATI36: status of boot-time CVC license check, applies if S318 > 0
- ATI57: query profile flags of current connections, same format as S register 102
- ATI58: query number of current connections, sum of ATI60..ATI67
- ATI59: returns '1' if a pre-set PIN code (by AT+BTK="…") is available

  returns '0' otherwise

  the PIN code itself is not displayed for security reasons

7.4 New S-Registers

- S318: Select CVC DSP image
  - 0 = disable CVC (DSP not used in a SCO link)
  - 1 = Headset 1 microphone (hs462, SYSID="B00A")

- 2 = Headset 2 microphones (hs542, SYSID="B107")
- 3 = Hands-free 1 microphone (hf441, SYSID="A006")

7.5 New asynchronous messages

- When a CVC image is loaded on entering a SCO (audio) link:

  "CVCID xxxx" whereby: xxxx = SysId (4 hex digits)

- When the security check for a CVC image has failed (invalid or no license key):

  HF"AU2" or HS"AU2"

  ERROR 83 will be returned as well.

  In this case the SCO link will remain but no audio can be heard due to failed security check. Make sure that a valid CVC license key exists and S318 contains the correct setting.

7.6 CVC Limitations

- Only the BC05 on-board codec is supported. External audio interfaces like PCM/I2S are not supported with this release.
- CVC only applies to SCO connections of the HF or HS instance. CVC does not apply to the audio gateway role of neither HFP (HFG) nor HSP (HSG).
- A license key is required for the CVC images. For development purposes, CSR provide free trial license keys. This firmware provides all necessary means in order to allow CVC trial development and license key management in conjunction with CSR tools. The application note "CVC on BTM5xx" describes the necessary details.

7.7 New Error Codes

- 82 : no CVC license key stored or more than 5 words (invalid length, ATI32)
- 83 : CVC security failed (on loading CVC image for a SCO connection)
- 84, 85, 86, 87 : f/w internal CVC error codes, should not occur with released firmware
- 88 : CVC SYSID request timeout, can occur on ATI35 if UART baud rate is too low
- 89 : HF request to disable NREC in HFG failed, because NREC feature is not supported by both ends. Support for both ends can be checked with AT+HFF?

  (NREC mask for HF=1; NREC mask for HFG=2)
- 90 : CVC boot time check failed: occurs if S318>0 at boot time and selected CVC image does not have a valid license key
- 91 : HF: "ERROR" was received from the HFG on a DTMF request

  ("AT+HFMi" on UART = "AT+VTS=i" on SLC)

7.8 Bugs fixed (compared to 14.1.2.1)

- A2DP 48kHz issue: when the module was configured as A2DP sink and the remote device sets up a DAC sampling frequency of 48kHz, the module has rebooted. This issue

has occurred for example with the Broadcom Bluetooth stack and a couple of mobile phones. It was a bug in the module's firmware and has been fixed. [Ref. 2-31]

- S555=3: On expiration of the post reset time window (see S554) the module reverts to not discoverable/not connectable (ATI27=0) instead of connectable only (ATI27=2). This has been fixed. [Ref. 2-27]
- PC-DCD issue: when connecting to a PC via SPP, the DCD line was not asserted (can be seen on e.g. Ezurio Terminal) during the connection. This has been fixed. [Ref. 2-30]
- When a remote device enables Sniff Sub Rating, the Bluetooth device address of that device was printed to the UART unexpectedly. This has been fixed now [Ref. 2-29]

7.9 Bugs fixed (compared to 18.1.2.2)

- Incoming audio in a SCO link was blocked when a CVC image was selected. This issue has been fixed.

7.10 Known issues

- When initiating an SPP connection from a BTM5xx to a PC with Microsoft Bluetooth stack, DCD is not asserted on the PC end. This can be detected by a terminal program, e.g. Ezurio Terminal. If the connection is initiated from the PC, then DCD is asserted as expected. [Ref 2-34]

7.11 General information

The first part of the firmware version number has changed from 14 to 18. This reflects the transition from bluestack firmware 23e to 23i. The change was required in order to support the 5th generation of CVC. ATI1 now returns the new bluestack build number: 6530.

8. Firmware Version 18.1.2.4 (engineering firmware)

8.1 New AT commands

- AT+HFFN?

  Query local (HF) and remote (HFG) NREC flag of HF/HFG supported features. An HFP SLC is required.

  Response: <HF_NREC>,<HFG_NREC>

  Range = 0..1

8.2 Bugs fixed (compared to 18.1.2.3)

- PC-DCD issue (SPP): this issue [Ref 2-30] was only fixed if the connection was initiated from the PC side. But if the connection was initiated from BTM51x, the DCD line was not asserted on the PC's virtual COM port (can be detected with EzurioTerminal.exe). This second issue has been fixed now as well [Ref 2-34].
- A2DP reconnection issue: after closing down an A2DP connection in an unclean way e.g. by switching off Bluetooth at the peer device during streaming, the BTM51x made an automatic reset (panic) on entering the next A2DP connection. This issue has been fixed now. [Ref 2-33]

8.3 General information

This release is engineering firmware and must be used for development purposes only.

9. Firmware Version 18.1.2.5 (engineering firmware)

9.1 New Features (compared to v18.1.2.4)

- AAC codec support for A2DP sink (subject to licensing, see section 9.6)
- PCM interface now supported
- Additional audio features for SBC encoder (A2DP sink), configurable with CSR's UFE/Universal Parameter Manager via SPI interface:
  - Parametric equalizer
  - 3D stereo enhancement
  - Compander
- CVC support added for HSG, HFG and SPP-SCO (was limited to HS and HF in 18.1.2.4)

9.2 Extended S-Registers

- S307 - enable optional A2DP codec:
  - Bit 0 (1) = APTX (source (encoder) or sink (decoder))
  - **Bit 1 (2) = AAC (sink (decoder) only)**
- S315 – SCO audio interface select:
  - 0 = internal (default), 1=I2S master, 2=I2S slave, **3=PCM**

9.3 New ATI commands

- ATI37: SPP-SCO link type:
  - 0=unknown, 1=SCO, 2=eSCO
  - Replaces the "(SCO)" / "(eSCO)" part of the previous AUDIO ON/OFF message (SPP-SCO / AT+BTAx), see 9.5

9.4 New Error codes

- 92: AT+BTAx not permitted, occurs if one of HF/HFG/HS/HSG and SPP is connected to one peer device. Reason: a SCO link is part of the HFP/HSP specification. Requesting SPP-SCO ("AT+BTAx") would cause confusion in this scenario.

9.5 Messages changed

- SPP-SCO (AT+BTAx):
  - AUDIO ON ([e]SCO) -> SPP"AU1"
  - AUDIO OFF -> SPP"AU0"
  - The information about the current SPP-SCO link type (SCO or eSCO) can be queried by ATI37

9.6 AAC Licensing

This firmware contains AAC technology which incorporates intellectual property owned by numerous third parties.

Supply of this product does not convey a license under the relevant intellectual property of those third parties nor imply any right to use this product in any finished end user or ready-to-use final product. An independent license for such use is required.

For details, please visit http://www.vialicensing.com.

9.7 SCO audio: internal / external audio interfaces

The matrix below gives an overview of combinations of profiles and audio interfaces that are currently supported. “SCO audio” refers to bidirectional mono audio for transmission of speech with 8 kHz sampling rate.

The PCM pins of the BTM51x share support for PCM, I2S and SPDIF. S315 selects one of these interfaces or the internal codec (“internal codec” refers to the on-board audio ADC/DAC, clock generator and antialiasing filters, hence the on-board analogue interface).

PCM in combination with CVC doesn’t work well (2). SPDIF is currently not supported but seems to be feasible (1). For I2S (normally used for stereo audio) make sure the sampling rate is configured to 8kHz if used with SCO, otherwise it will sound very strange due to the sampling rate mismatch.

		HF [S102=$10] **HS** [S102=2]	**HFG** [S102=$40] **HSG** [S102=8]	**SPP-SCO** [AT+BTAx]
CVC disabled [S318=0]	**Internal Codec** [S315=0]	✓	✓	✓
	PCM [S315=3]	✓	✓	✓
	I2S [S315=1/2]	✓ (8kHz)	✓ (8kHz)	✓ (8kHz)
	SPDIF	⊘ 1	⊘ 1	⊘ 1
CVC enabled [S318>0]	**Internal Codec** [S315=0]	✓	✓	✓
	PCM [S315=3]	⊘ 2	⊘ 2	⊘ 2
	I2S [S315=1/2]	✓ (8kHz)	✓ (8kHz)	✓ (8kHz)
	SPDIF	⊘ 1	⊘ 1	⊘ 1

(1) SPDIF not supported currently, but seems to be feasible
(2) Seems to be a data format issue (CVC creates/expects data in a format for the internal audio codec, not PCM; CSR support required)
(3) Internal Codec=analogue, all other interfaces are digital external audio interfaces

The PCM interface and the I2S interface may require further configuration which can only be achieved by PS-Keys. Please refer to the CSR BC05-EXT data sheet, chapter 10.

PS-Keys can be modified by “PSTool.exe”, provided by CSR, via SPI or UART (BCSP mode).

Alternativeley, PsUpdate.bat, a tool provided by Laird Technologies, allows modification of the following PSKeys via UART:

PSKEY_PCM_CONFIG32	&01B3
PSKEY_PCM_FORMAT	&01B6
PSKEY_DIGITAL_AUDIO_CONFIG	$01D9

The values for these keys are passed to PsUpdate.bat in a *.psr file.

9.8 SCO input/output channel

If SCO (which is mono) is routed over an audio interface, which normally supports stereo, the left channel is selected for the input signal.

	Input Channel (SCO)	Output Channel (SCO)
Internal Codec	A (left)	A and B (left and right)
I2S	Left	Left and Right

*Note: on the BTM51x mini dev. kit the stereo input connector, left and right channels are swapped (tip=right, ring=left, sleeve=ground,) This is a known issue and will be fixed with the next revision of the dev kit. The correct assignment for the jack is: tip=left, ring=right, sleeve=ground.

9.9 Bugs fixed (compared to 18.1.2.4)

- HFP/HSP SCO request when SPP enabled: When one of HF/HFG/HS/HSG was enabled along with SPP and an incoming SCO request occurred, the message “AUDIO ON (SCO)” was printed to the UART, but actually something like HF”AU1” would be expected. A subsequent status mismatch was caused too. This issue has been fixed. [Ref 2-7]

9.10 General information

This release is engineering firmware and must be used for development purposes only.

10. Firmware Version 18.1.3.0 (production firmware)

10.1 Features

This release does not contain new features compared to 18.1.2.5. All features which have been added by engineering releases since v14.1.2.0 are part of this release.

10.2 Regression Testing

Automated regression tests have been executed to cover all implemented features as well as fixed bugs to a reasonable level. This aims to make sure that all AT commands and features function as described in the BTM51x user manual. However, given the huge amount of possible combinations of Bluetooth profiles, roles and S-Register settings, there may be untested use cases left.

This firmware is qualified for production. The BTM51x user manual is updated with this release as well.

10.3 Bugs fixed (compared to 18.1.2.5)

- ATI57: response for AVRCP flag was wrong (0x80), is now fixed (0x100)
- HFP: in the first SCO link (audio) after a module reset, the audio signal was not routed to the ADC/DAC, this has been fixed
- Auto SCO release on CVC security fail: when a SCO connection (audio) is established with CVC enabled (S318>0) and the CVC security check fails (ERROR 83), then the module automatically releases the SCO connection. The failed security check would block any audio signal to be routed through the ADC/DAC, so the auto release just cleans up this exceptional scenario. With properly configured CVC, the security check should always pass. However, during the development phase this issue can occur easily.

10.4 Changed S-Register defaults

- S332 = 1 in factory default setting (was 0 before).

  This allows ATH1108 and ATH* for the HS instance.

10.5 Limitations

- The maximum length for extended inquiry data is 112 Bytes. The Bluetooth specification allows up to 240 Bytes, but this cannot be achieved on BTM510/511 due to internal memory limitations. [Ref 3-1]
- External audio codec I2S master clock: in addition to the I2S signals (SD_IN, SD_OUT, WS, SCK), external audio CODECS often require a high frequency synchronisation clock from one master clock source in the system. This master clock would typically be created by the BTM51x and the clock frequency would be 12MHz or 24MHz. BTM51x has no means of providing this master clock to an external I2S device. If a 12MHz or 24MHz master clock is required, then BTM52x should be used instead of BTM51x. If master clock synchronisation is missing, then artefacts will be audible in periodic intervals. In the use case of a wave file player/recorder (no codec) the I2S signals are sufficient and no master clock synchronisation is required. [Ref 3-2]

10.6 Known issues

- A connection attempt of any profile fails ("NO CARRIER") if the peer's device BD address is stored in the local list of trusted devices (AT+BTT? or AT+BTW?), but for any reason the local device's BD address is not stored in the peer's device trusted device list any longer (link key missing). [Ref 3-3]

  Workaround (a) (recommended): use AT+BTW<BdAddr> to initiate new pairing to generate new link keys on both ends.

  Workaround (b): the link key for the remote device can be deleted from the trusted device list (AT+BTD<BdAddr>) or from cache (AT+BTDW). A new connection attempt (e.g. AT+SPD<BdAddr>) should initiate new pairing automatically.
- HF: ATH111E and ATH* (for HF) do not respond with 'OK' but with 'NO CARRIER' only. [Ref. 3-5]
- HFG, call records: There are currently no AT command available for the following purposes:
  - Clear a waiting call [Ref. 3-6]
  - Make a held call active [Ref. 3-7]
- HFG: "AT+HFGE<ext_err_code>": an issue with extended error codes has been observed. AT+HFGE<ext_err_code> does not work as expected. Workaround: do not use extended error codes but simple error messages, i.e. AT+HFGE (without parameter). [Ref. 3-8]
- EIR: after repeatedly issuing AT+BTE+? or AT+BTEW? (provided data is stored in the RAM and persistent buffer) the commands stop working or only display a part of the buffered data. It has been observed that this issue occurs after in the regression tests after the 42nd repetition of the test sequence. [Ref. 3-9]
- HF: order of HF"AU0/1" messages: it has been observed that the position of HF"AU0" or HF"AU1" can vary within the asynchronous message sequence during a call or a call setup. [Ref 3-10]
- HSG: the asynchronous message 'FS8000,INT' is sent prior to 'HSG"B"' which is not correct. From a the logical sequence point of view one would expect 'HSG"B"' first and 'FS8000,INT' thereafter. However, the content of these messages is correct. [Ref. 3-11]
- HSG, CVC enabled: a redundant 'HSG"AU1"' is being sent between 'HSG"B"' and 'CVCID …' [Ref 3-12]
- AVRCP direction indicator missing: AVRCP does not display a direction indicator (incoming '<' or outgoing '>') when a connection is established. Compared to all other profiles this is inconsistent. [Ref. 3-13]
- EIR: when filling up the RAM buffer with > 112 bytes of EIR data (AT+BTE+"…") and writing the buffer to the baseband (AT+BTE~) a module panic occurs (reset). The length of EIR data is limited to <= 112 bytes with this release. [Ref 3-14]